Oxygen uptake of *Polypedates maculatus* (Gray, 1830) larvae during their developmental stages

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ABSTRACT. - *Oxygen uptake by tadpole of* Polypedates maculatus *is a function of body weight. The initial low rate of oxygen consumption is due to a lesser activity of the tadpoles in the absence of the limbs. Emergence of hind limbs increases the activity of the animal and it corresponds with the sudden rise in the oxygen consumption rate. The* qO_2 *uptake (µl of oxygen / g wet weight / hour) is maximum in the earlier developmental stages and it declines as the developmental process proceeds, but attains a second peak during metamorphic climax. This may be due to a calorigenic effect (secondary effect) of thyroxin.*

INTRODUCTION

The larvae of *Polypedates maculatus* (Gray, 1830) are found in plenty in temporary water ditches during the rainy season. Their life-history strategy is based on avoiding the desiccation of their breeding grounds. MISHRA & DASH (1983) have reported rapid differentiation process towards the end of the larval period as part of the life-history strategy of these larvae; the size at metamorphic transformation is not affected by the degree of

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crowding, which lengthen the time to reach metamorphic climax (MISHRA & DASH, 1984).

During the metamorphic process of Amphibian larvae under the influence of active thyroid hormones there is always a high level of oxygen uptake (LEWIS & FRIEDEN, 1959). FUNKHOUSER & FOSTER (1970) directly correlated thyroid activity with oxygen uptake of *Hyla regilla* tadpoles. The present study was designed to determine oxygen uptake strategy of *P. maculatus* larvae during their development.

MATERIALS AND METHODS

The eggs of *P. maculatus* were collected from the froggery in the last week of May. They were brought to the laboratory and were allowed to hatch in laboratory conditions (33°C; Relative humidity 48 % maximum and 22 % minimum). The larvae were mixed in an aquarium to create a genetically homogeneous population and the larval population was maintained in filtered tap water medium conditioned with Sodium thiosulphate (NACE & RICHARDS, 1972).

Larvae were blotted damp dry, weighed in a sensitive chemical balance (± 1 mg) and staged before each measurement of oxygen uptake. The tadpoles were staged after TAYLOR & KOLLROS (1946). To determine the oxygen uptake, batches of 5 tadpoles in triplicate were incubated with double distilled water at room temperature in an air tight conical flask with known volume, for four hours in initial stages of development, and two and half hours to one and half hours in the later stages of development. The oxygen content of the water was determined by modified WINKLER's method (WELCH, 1948). Here manganous chloride was used instead of manganous sulphate and concentrated hydrochloric acid was used to liberate the iodine.

RESULTS AND DISCUSSION

The individual wet weight of *P. maculatus* larvae increased from the time of hatching until the stage of metamorphic climax. The best fit (statistically) growth curve shows a sigmoid pattern. The increase in wet weight is slow through stages I-V (lag phase) followed by a rapid increase

Table I. - Oxygen consumption by the developing larvae of *Polypedates maculatus*.

Stage	Body live weight (mg)	µl of oxygen consumption/h/ individual tadpole
I	45.13 ± 3.31	32.49 ± 1.86
V	96.53 ± 12.76	33.29 ± 4.55
X	301.53 ± 24.00	72.32 ± 1.58
XI	381.13 ± 23.28	128.66 ± 7.44
XVII	467.86 ± 24.28	156.37 ± 20.65
XX	531.00 ± 24.76	201.56 ± 6.11
M.C.	605.00	167.49 ± 9.57

in weight through stages V-XX (linear phase of growth) which is again followed by slower growth through metamorphic stages (upper asymptote)(Table I, fig. 1). The rate of oxygen uptake per tadpole was maintained up to stage X in spite of the increase in wet weight and shows a sudden jump at stage XI and continues to increase in a hyperbolic fashion up to stage XX (fig. 1). But during the metamorphic stages (non feeding stages) the rate of oxygen consumption per tadpole decreases ($t = 7.035$; $df = 8$; $p < 0.001$). In general, oxygen consumption of *P. maculatus* tadpoles seems to be a direct function of the body weight (fig. 1) a finding in agreement with the generalization that metabolism varies with some fractional exponent of body weight (ZEUTHEN, 1953). The larvae up to stage X are in the premetamorphic stage without any legs for movements and were less active. Probably, the lower rate of oxygen consumption is because of lesser activities of the larvae. With the emergence of hind limbs the activity increases at stage XI which corresponds with sudden rise in the oxygen consumption rate per tadpole. During metamorphic stages (non feeding transforming stages) the rate falls down but is maintained at a high level signifying high internal activities (metamorphic transformations of internal organs).

An initial high rate of qO_2 (µl of oxygen / g wet weight / hour) is followed by rapid decline through premetamorphic stages (fig. 2). It then slightly increases and is maintained through prometamorphic stages (XI-XX) until metamorphic climax during which time there was a second peak. The oxygen uptake of the larvae at metamorphic climax is slower than that of the

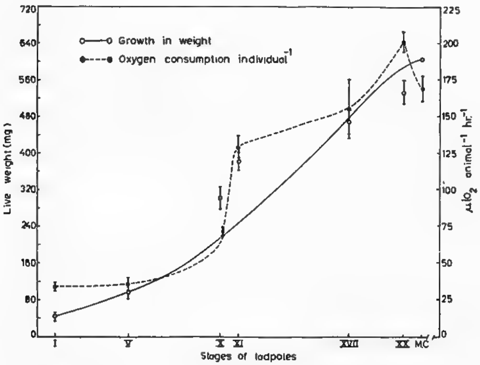

Fig. 1. - Mean individual wet weight and oxygen uptake per animal.

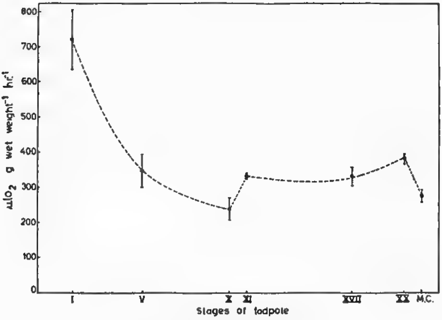

Fig. 2. - Mean qO_2 in *Polypedates maculatus* larvae.

previous stage ($t = 10.956$; $df = 8$; $p < 0.001$), but is maintained at a higher level than the premetamorphic animal (stage X). This is in accordance with the findings of others that high rate of oxygen uptake at metamorphic climax is not greater than those of prometamorphic animals (WILLS, 1936; WITSCHI, 1956; FUNKHOUSER & MILLS, 1969). Maximum rate of oxygen consumption qO_2 in Amphibians normally occurs early in development, the specific time depending upon the species (GORBMAN, 1964). The peak rate in P. *maculatus* is found around stage I.

In P. *maculatus* the rate of oxygen uptake per tadpole took a sudden increase from 72.23 µl to 128.66 µl per tadpole per hour from stage X to stage XI. The qO_2 also follows the same pattern. The rate of oxygen uptake per tadpole then went on increasing reaching a maximum of 201.56 µl per tadpole per hour at stage XX. At metaporphic climax stage although the rate of oxygen consumption dropped yet it was quite high (167.485 µl). It is interpreted that this increase in oxygen uptake from stage XI to XX and the high oxygen uptake value at metamorphic climax is correlated ($r = 0.95$) to the higher activity and growth rates of the tadpoles due to the significant activity of thyroxin. This finding agrees with FUNKHOUSER & FOSTER (1970) that the secondary effect of thyroxin in developing Amphibia is the calorigenic effect.

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RESUME

La consommation d'oxygène par les têtards de *Polypedates maculatus* (Amphibien, Anoure, Rhacophoridé) varie au cours de leur croissance en fonction de leur poids. Au début, le faible taux de consommation d'oxygène par individu est dû à une moindre activité des têtards encore dépourvus de pattes. L'apparition des pattes postérieures accroît l'activité des têtards et correspond à une brusque augmentation de leur taux de consommation d'oxygène. La quantité d'oxygène consommé par gramme de poids frais (qO_2) est maxi-

male durant les premiers stades larvaires et diminue ensuite au fur et à mesure du développement, mais elle présente un second pic au moment du climax métamorphique. Ceci est probablement dû à l'effet calorigène (effet secondaire) de la thyroxine.

(Résumé rédigé par J.-J. MORERE)

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